POLLUTION MONITORING IN LAKE CHAMPLAIN USING ERTS-1 IMAGERY

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This constitutes a significant result report on 7.C, Lake Pollution Surveys and 4.D, Limnology

8 pgs.

BACKGROUND

The detection of a major pollution plume emanating from the International Paper Company's Fort Ticonderoga operation was described in our significant result report of November 1972. A major plume was seen in the ERTS coverage of October 10, Image no. 1079-15115, and it was observed that the plume configuration agreed with earlier lake surveys made in the vicinity of the submerged, paper mill, discharge pipe. At that time, it was not known what other configurations the plume might take due to seasonal changes in the lake level and lake current intensity. Subsequent coverage of the discharge plume area during the April overflights of ERTS-1 provides additional information and verifies our earlier expectation that monitoring of the plume configuration would be possible. This report comments on the subsequent coverage and indicates its utility for important resources decisions currently pending.

MONITORING CHANGES IN POLLUTION PATTERNS AND OUTPUT

MSS band 4 has again been proven to be the most useful ERTS MSS band for assessing the magnitude and extent of the pollution plume emanating from the International Paper Company's new plant just north of Fort Ticonderoga, N.Y. Two scenes are presented in this report representing a distinct seasonal change in the level and current conditions of Lake Champlain as well as contrasting discharge outputs from the paper mill's treatment plant. Both April 7 and 25, 1973 are shown, and at this time, lake levels were at rather high stages (100.4 and 99.4 feet respectively). Low atmospheric transparency on April 25 has a somewhat degrading effect on that image, but detection and recognition of the plume was not seriously affected.

Due to the poor representation of the shoreline on band 4, the position of the plume in the lake may be determined by superimposing bands 4 and 6 or 7. The near-infrared band provides excellent shoreline definition and makes it possible to note the extent of the plume area. In addition, the near-infrared bands reveal the shoreline position with such clarity

that the inundating effects of the spring lake levels on low-lying areas can be assessed. This is in itself a new significant result and will be discussed in a separate report.

Both bands 4 and 6 are shown for the April 25 (Image no. 1276-15073) view (Figs. 1 and 2) of that part of Lake Champlain between Fort Ticonderoga to the south and Schoolhouse Bay to the north.[1] This is the turbid, shallow, southern leg of Lake Champlain which has a general north-flowing current throughout most of the year. The plume area on the April 25 imagery extends more to the north and east than previously observed and this configuration is apparently a reflection of the stronger north-flowing current in this part of the lake during spring (See Fig. 3). Winds recorded at Burlington, Vermont were from the north at 1000 hours local time and this wind pattern was persistant before and after the overflight of ERTS. The northward trend of the plume area is indicative of the dominating influence of the general lake current. The plume area is somewhat larger than previously observed and represents a fairly high discharge. The plant discharges paper mill wastes at a rate of approximately 21 million gallons per day. The usual high level of general turbidity in the water of this portion of the lake shows as a light tone in the image compared to the darker tone of the plume area which results from the suspended paper mill wastes which produce an overall brownish coloration of the water.

On the April 7 imagery, (Image No. 1258-15073) a contrasting view is presented (Fig. 4) in which the discharge is at an extremely low level so the plant discharge is barely discernible by the slightly darker tone in a pattern oriented directly over the submerged diffuser pipe. April 7 occurred on a weekend (Saturday) when the plant was not in full operation, while the April 25 view presented previously shows a midweek discharge (Wednesday) when the mill was in full operation. Current conditions and lake levels between

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[1] Figs. 1, 2 and 4 are direct 4x enlargements of ERTS 9" positive transparencies made on Polaroid Type 52 film.

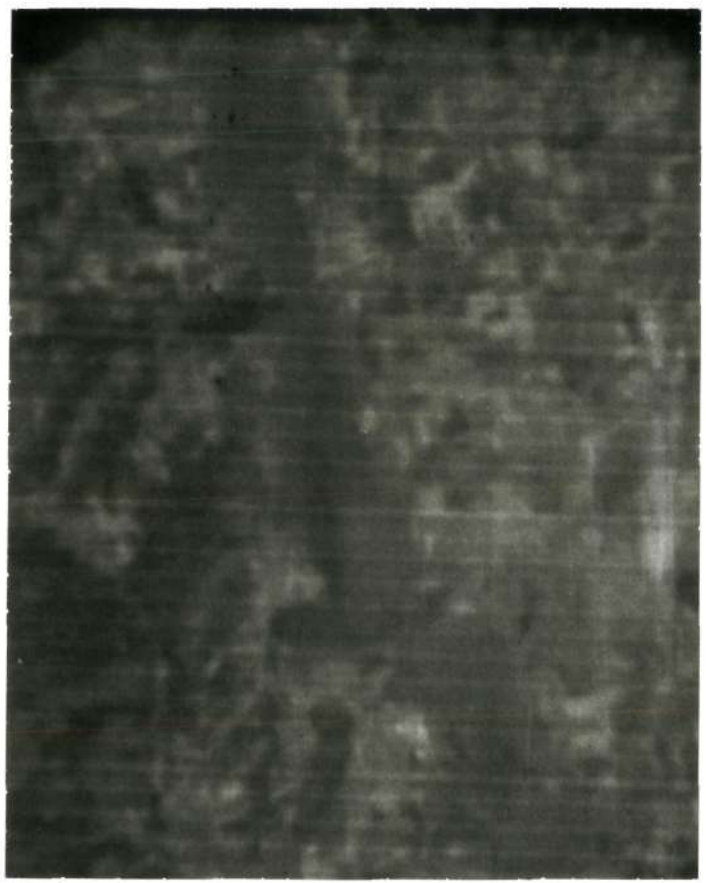

Fig. 1. 4x enlargement of band 4, ERTS Image 1276-15073, centered on pollution plume area (dark tone in lake). Plume extends toward the north (top) and east. April 25, 1973.

Fig. 2. 4x enlargement of band 6, of the same scene as in Fig. 1. Shoreline definition and areas of inundation show clearly. This image was superimposed on band 4 in Fig. 1 in a multispectral viewer to produce Fig. 3.

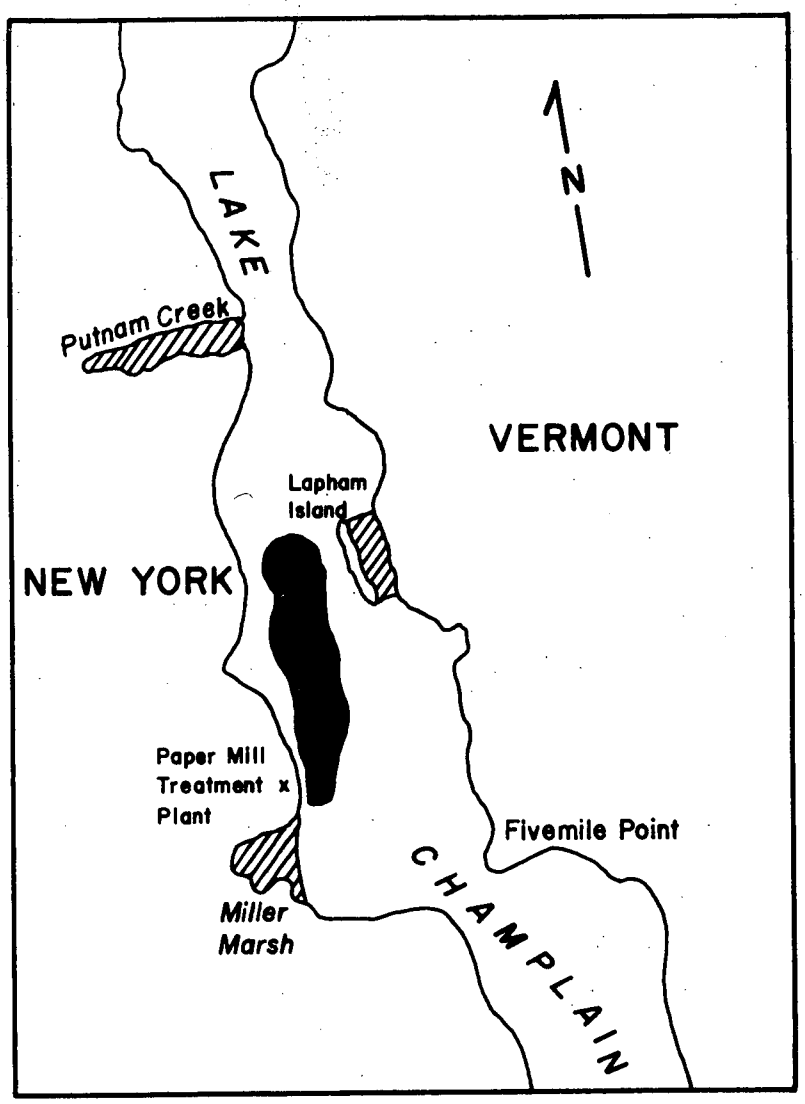

Fig. 3. Map of pollution plume generated from multispectral viewer screen (approx. scale 1:84,000) using bands 4,5, and 6. The extent of the pollution plume (black) and major inundated areas (lined) are shown.

Fig. 4. A 4x enlargement of band 4, ERTS Image no. 1258-15073 (April 7, 1973) showing minimal discharge (below red dot) of weekend operation.

the 7th and 25th of April were essentially the same with only a one foot difference in lake level. Winds at Burlington at 1000 hours local time were from the north at 13 knots.

SUMMARY AND RESOURCES SIGNIFICANCE

These additional views of the pollution plume from the International Paper Co. mill located in New York just north of Fort Ticonderoga have served to reaffirm the investigator's earlier expectations that the paper mill waste discharge into Lake Champlain could be monitored. The cummulative affect of these images and others to come will be to provide data to construct a model depicting the plume configuration in differing seasons and limnological conditions. Thus, each time ERTS provides an image of the pollution study area, more information is provided to meet that goal. This information can be combined with aircraft data taken under different circumstances.

When the pollution plume observed in MSS band 4 imagery is compared to the shoreline information clearly seen on the near-infrared bands and transferred to a map base, it becomes apparent that the plume area extends into Vermont. New information based on continuing lake surveys indicates a discernible amount of new sludge deposit on the lake floor. The relationships between the plume area and sludge sedimentation will require further analysis based on a continuing flow of data from ERTS, aircraft and lake surveys. All of this information has a direct bearing on the ongoing court suit which Vermont has brought against the International Paper Co. and the State of New York for pollution of its waters. The plume data documented here will be made available to the State's Attorneys Office, State of Vermont for possible application in the ongoing resources action now in progress at U.S. Supreme Court level.

SIGNIFICANT RESULT SUMMARY

7.C Lake Pollution Surveys
4.D Limnology

ERTS band 4 imagery (500-600 nm.) of April 7 and 25 (Images No. 1258-15073 and 1276-15073) show contrasting pollution effects due to seasonal and discharge variations. The pollution plume emanating from the International Paper Co. mill just north of Fort Ticonderoga was first detected on October 10 ERTS imagery (band 4) and now has been documented during spring high lake level conditions. The plume was observed extending further to the north and east (April 25) than under low water conditions of October 10. This northward extension reflects a stronger northward current flow expected in the turbid southern leg of Lake Champlain. The extensive plume of April 25 represents full plant operation while the April 5 scene shows some plume traces directly over the submerged diffuser, discharge pipe representing minimal discharge during weekend plant operation. The ERTS documentation above will be used in developing a model of plume behavior under varying environmental conditions and will hopefully serve to assist in a major resource decision pending at U.S. Supreme Court level. (Vermont vs. International Paper Company and State of New York).